# THE BOX BUTTE TABLELAND

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The Box Butte Tableland (fig. 1), a physiographic subdivision of the High Plains Region of the United States, is a rather flat, undissected upland of few streams and scant rainfall. The area received its name from a prominent butte-like landmark located in the northeastern part of Box Butte County, Nebraska (fig. 2).

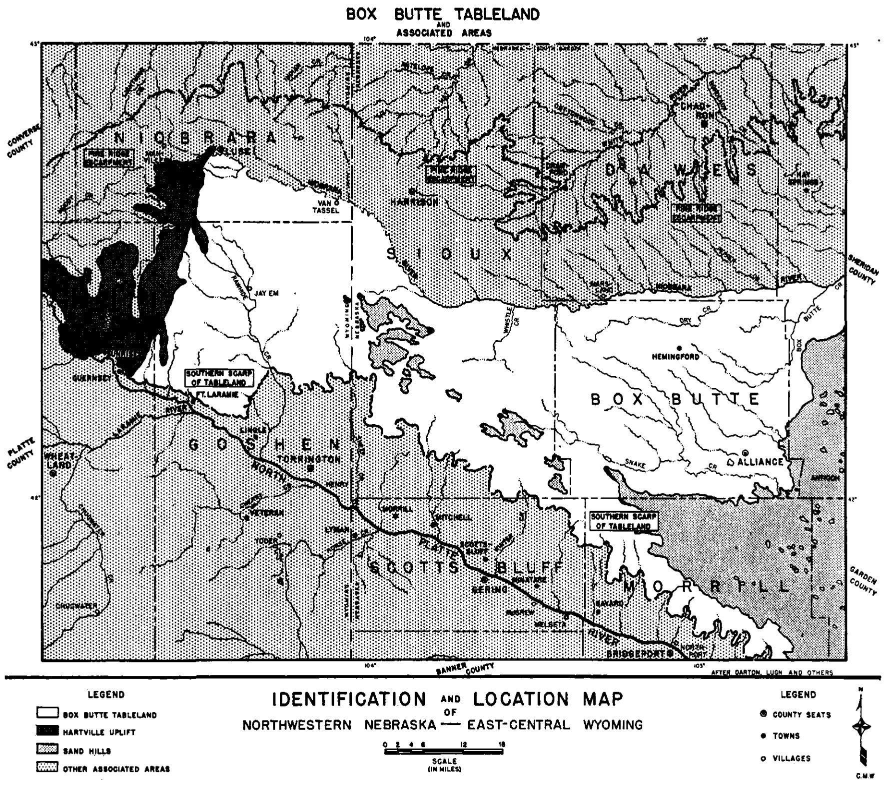


FIGURE 1. Location map of the Box Butte Tableland.

Box Butte offers mute evidence of a former, much higher level of the High Plains Region, now greatly reduced through the seemingly endless action of wind and water. The upland (fig. 3) is typical of the fluvial remnants of a vast detrital fan which, in geologic ages now long past, was spread out to the eastward from the base of the Rocky Mountains by widely shifting but heavily laden depositing streams (Johnson, 1902).

The tableland presents three distinguishing characteristics: (1) a comparatively flat plains country; (2) a practically treeless but grass-covered expanse; and (3) an area in which rainfall is usually insufficient for tillage agriculture common to regions of humid climate. Relatively speaking, the country is high, dry, and healthful. There are broad plains and scattered buttes; few streams; tornadoes, cloudbursts, dust storms, hot winds, cold waves, and blizzards; short nutritious grasses that in dry seasons are often destroyed by devastating fires; bellowing cattle and bleating sheep; barbed wire fencing; whirling windmills; isolated farm- and ranchsteads; and small towns so widely scattered that the distances between them tend to discourage the normal social development of a people.

FIGURE 2. A view from the southwest of Box Butte for which the entire tableland, as well as a county and creek, are named. The original cap rock was removed by early settlers for foundation stones in houses and barns.

## LOCATION AND EXTENT

The Box Butte Tableland extends from the rim overlooking the North Platte Valley (fig. 4) northward to the deeply dissected *breaks* of the Niobrara Valley, and from the grass-covered Sandhill Region of north-central Nebraska westward to the Hartville Uplift in east-central Wyoming (fig. 5). Well-marked by physiographic features characteristic of a semiarid country, this tabular upland consists of approximately 2,820 square miles, about 2,000 of which are in the state of Nebraska.

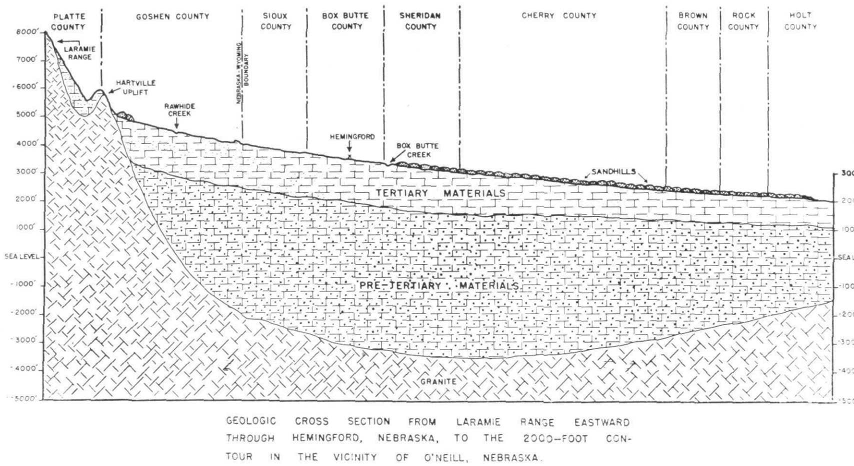


FIGURE 3. Geologic cross section of eastern Wyoming and western Nebraska. Adapted from Condra, Darton, Lugn, and others.

## TOPOGRAPHY AND STRUCTURE

Contrary to widespread belief, the landscape is not one of wearisome sameness. In addition to the large stretches of level, monotonous plains country, it is marked by several lonely buttes; by low hills and ridges; by small, widely separated intermittent drainage ways and streams, fringed occasionally by clumps of cottonwoods and willows; and by numerous but widely scattered basin-like depressions believed to have been formed by wind erosion of exposed silty and sandy beds of the Tertiary (Lugn, 1935). The basins have an elongation from northwest to southeast and are often occupied by ephemeral ponds. A thin layer of hardpan occurs within a few inches of the surface of the depressions, sealing their bottoms to such an extent that precipitation disappears almost entirely through evaporation, little by seepage. The drainage ways and streams have for the most part a northeast, east, or southeast trend, thus reflecting the general slope of the tableland.

FIGURE 4. Southern rim of the Box Butte Tableland overlooking the valley of the North Platte River in the vicinity of Bridgeport, Nebraska. The escarpment, rising from 500 to 1000 feet above the valley's bottom lands, presents a distinct barrier to transportation.

The area follows the normal inclination of the High Plains Region, sloping from west to east. Altitude and declivity are due mainly to the geologic structure and climatic conditions experienced in the past. In addition to its easterly slope, there is a slight tilt from northwest to southeast, with the highest altitude of slightly more than 5,000 feet found in the northwestern corner of the tableland and the lowest, approximately 3,800 feet, in the southeastern part.

Structure is comparatively simple. Below the mantlerock and exposed in many places are well-defined sedimentary formations of fluviatile origin which lie in a nearly horizontal position (fig. 6). These Tertiary deposits consist principally of poorly cemented sandstones and conglomerates laid down by heavily laden Rocky Mountain streams; extensive beds of sandy clays and shales are also present. One of the more resistant formations, the Arikaree, serves as a cap rock for most of the area and is largely responsible for the broad, nearly flat or gently rolling tabular uplands (Darton, 1903, 1905). The Arikaree is comprised largely of thick beds (700–800 feet) of fine, poorly cemented sand separated by thinner layers of hard, fine-grained, dark-gray sandstones which vary greatly in hardness and are characterized by extensive pipy concretions. In examining an outcrop of the Arikaree, there is usually found a rather sharp face and well-developed talus slope.

The more sandy materials can be broken without difficulty and the pieces quickly disintegrated when rubbed between the hands, thus showing the weakness of cementation. Some of the sandy beds are argillaceous with the colors uniformly light gray.

In many localities this particular type of bedrock gives rise to steep walled canyons, especially noticeable along the southern edge of the Box Butte Tableland, and in the lower course of Dry Creek, an intermittent tributary of the Niobrara River which has deeply dissected the northern edge of the upland in Box Butte County. The Arikaree not only constitutes the crest of the rim overlooking the North Platte Valley but extends, as previously pointed out, throughout most of the tableland, thereby forming so to speak, a pronounced platform.

FIGURE 5. Eastern front of the Hartville Uplift, with the course of Rawhide Creek marked by a narrow line of brush and small trees. The ranchstead in the right background occupies a choice site but is confronted by problems which arise from isolation.

In regard to the conglomerate deposits it appears that streams first carved out valleys in the Tertiary beds and then at a later period filled them with coarse sands and gravels, the latter often being crystalline in origin. With the passage of time these deposits became cemented through the presence of iron and lime, thereby forming the existing conglomerates. Tea Kettle Butte, located north of Bridgeport, Nebraska, and adjacent to the southward-facing edge of the Box Butte Tableland, offers excellent specimens of these conglomerate materials.

A somewhat unique feature of the Box Butte Tableland is the presence of several dunesand tracts. Dunes occur in southern Box Butte and Sioux counties, Nebraska, with occasional scatterings in west-central Box Butte, across central Sioux County, and into Goshen County, Wyoming. The dune areas in the central part of Sioux County can be accounted for by exposure to the elements of the sandier layers of the Arikaree. The intermittent belt of sand hills extending along the southern margins of the Box Butte Tableland cannot be explained so readily. This accumulation of sand may have resulted from eroding of the Arikaree, but most likely it is from the North Platte River bed, where the winds have picked up the dry sand during periods of low water and deposited it upon the tableland's edge. The dunes on the

FIGURE 6. Horizontal layers of the Tertiary fronting on the Niobrara Valley. This section of the valley near Agate, Nebraska, is used for "wintering" range cattle. The trail in the foreground connects two ranchsteads located on adjoining holdings.

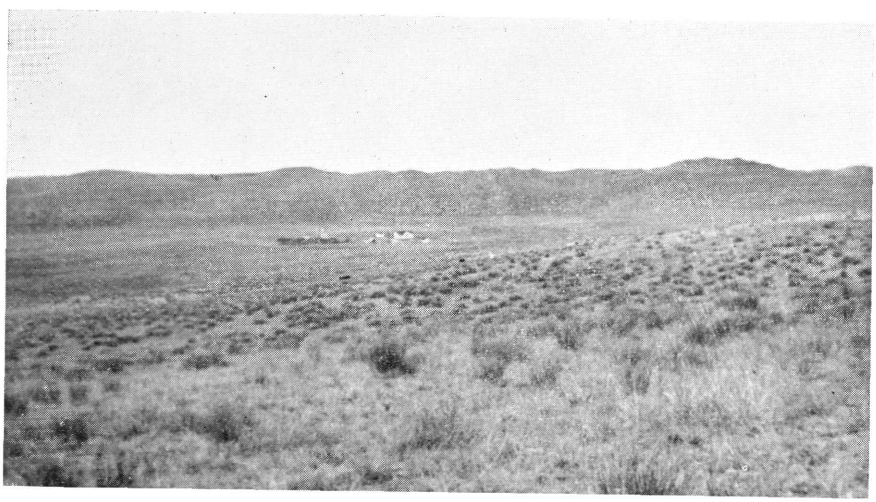

FIGURE 7. Line of dunes rising 200–250 feet along the northwestern edge of this basin offers protection to the ranch buildings (center background) from winter storms. Basin tracts usually furnish excellent grasses for grazing and haying.

Box Butte Tableland vary from 50 to 150 feet in height, and the tracts consist largely of assemblages of irregular grass-covered sand dunes with intervening basins and valleys (fig. 7). In a few instances they rise from 200 to 250 feet above the surrounding plain.

### DRAINAGE

Scarcity of streams characterizes the tableland, with steep gradient tributaries of two major rivers, the North Platte and the Niobrara, draining the area. In general, tributaries of the North Platte drain the southern portion and those of the Niobrara, the northern. Both rivers carry water throughout the year, but in periods of exceptionally low precipitation and heavy withdrawals for irrigation purposes there may be little if any water visible in their beds. Losses through evaporation and sub-surface drainage are especially high in each stream.

Tributaries of the North Platte and Niobrara which have their *heads* in the Box Butte Tableland are not, for the most part, perennial streams. Although often carrying flood waters in the late spring or immediately following a summer thunderstorm of great intensity, they dwindle to mere trickles of water or disappear entirely during the months of July and August; this condition may continue throughout the fall season if precipitation is light. In the Wyoming section the North Platte River receives only one northside tributary of any consequence, Rawhide Creek, which drains approximately half of the Wyoming portion of the

FIGURE 8. Valley of Rawhide Creek offers an attractive site for ranchstead located a few miles southeast of Jay Em, Wyoming. Castle Rock in background adds much to the beauty of the place. The tower at rear of house, a so-called "wind charger", furnishes electricity for lights and small household appliances.

Box Butte Tableland. This stream heads a short distance to the west of Rawhide Buttes, draining a small part of the eastern front of the Hartville Uplift. It has some local importance in supplying water for livestock and irrigation. The valley of Rawhide Creek, while not large, is especially attractive where clumps and groves of cottonwoods, willows, and elm border the stream (fig. 8). In the Nebraska portion of the tableland occur numerous tributaries of the North Platte River, none of which has a drainage area as great as that of Rawhide Creek.

Only a few tributaries enter the Niobrara from the south, the more important being Whistle and Box Butte creeks. Box Butte Creek begins its course immediately east of Hemingford, Nebraska, and flows in an easterly-northeasterly direction, skirting Box Butte on the northwest. The remaining tributaries are of the sand-draw type, intermittent during most months of the year. Some of the tributary streams occupy valleys quite similar to the Niobrara in shape, but somewhat modified; others flow in deep canyons and are bordered by strips of bottom land only in their lower courses where gradients are much reduced.

A few small drainage ways, independent of either the North Platte or Niobrara rivers, do occur, particularly in the flatter sections of the area. One outstanding tract of such drainage occupies the southeastern part of Box Butte County in the vicinity of Alliance, Nebraska. Here the drainage ways are intermittent with a northwest-southeast trend, losing whatever water they may carry through evaporation and seepage as they encounter the loose sands of the adjoining Sandhill Region on the east and southeast.

Largest of the intermittent streams is Snake Creek which heads in the sand dune area of southeastern Sioux County. This stream flows in a rather shallow valley, receiving most of its water, the volume of which is generally quite small, from numerous springs. Following an easterly course across Sioux and Box Butte counties, its waters are finally emptied into a drainage basin at the southeastern corner of Box Butte County. This depression extends eastward for some distance, with the sandhills bordering it on the north and south. In times of heavy precipi-

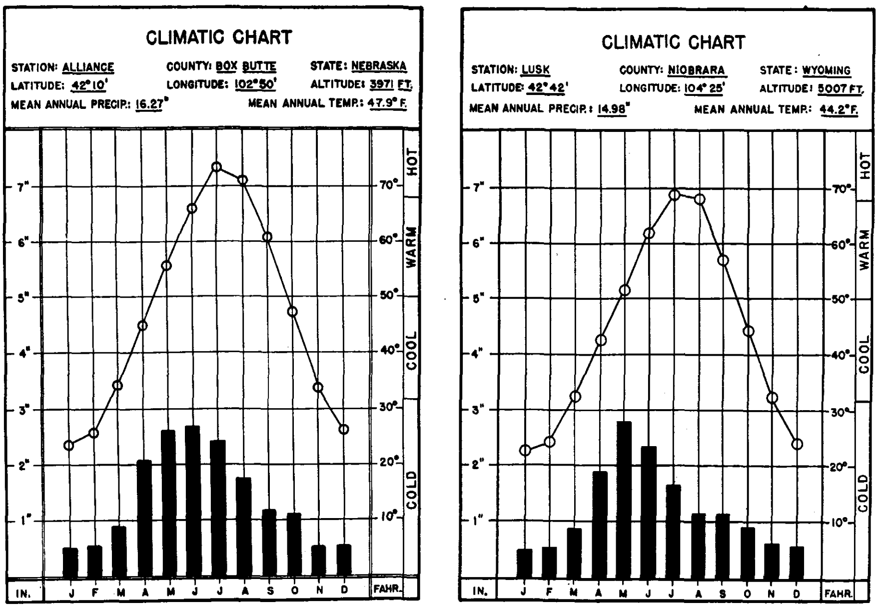


FIGURE 9. Climate determines largely the usability of an area or region, particularly for agricultural purposes.

tation Snake Creek empties so large a volume of water into the basin that there is much flooding of pasture lands, hay meadows, and ranchsteads; it may take several weeks for the excess water to seep away eastward through the loose sands.

In general the Box Butte Tableland is well-drained, with water standing only occasionally and then usually for but short periods in even the larger upland basins where the drainage has not been thoroughly established. Due to low precipitation, high rate of evaporation, the rather sandy nature of the soils, and the porous geologic materials underneath, drainage is quite satisfactory although in certain instances it may be excessive. Usually spring-fed, some marsh and swamp tracts occur; others are found along the watercourses and generally support a heavy grass cover.

## CLIMATE

In its essential aspects the climate of the Box Butte Tableland is typically continental with middle latitude, semiarid characteristics (fig. 9): wide seasonal ranges in temperature with high maximums occurring during the months of July and August and correspondingly low readings in the winter season; rapid and non-periodic changes in temperature, especially during the winter months when cyclonic storms reach their peak; wide diurnal ranges in temperature; mean annual precipitation of less than 17 inches, with a late spring and early summer maximum; dryness of the air; abundance of sunshine; and strong prevailing winds which are northerly and northwesterly in winter and southerly and southeasterly in summer. The area experiences a wide variety of weather phenomena: thunder and hail storms, tornadoes, and desiccating hot winds in summer; driving sleet storms, cold waves, and blizzards during the winter and spring seasons. Chinook winds can be expected during the spring, the warmth and dryness of which account for the rapid disappearance of snow, a heavy covering often melting within a few hours.

Changes in weather are frequent from day to day or from week to week, these short period weather conditions being due to the invasion of large air masses of different characteristics, such as warm, moist tropical air from the Gulf region;

FIGURE 10. Land abandonment, caused mainly by attempts to apply farming practices unsuited to a semiarid region, has been characteristic of the Box Butte Tableland since its early settlement. The sod house and clay-chinked shed as shown above are of common occurrence and many date back to the period immediately following passage of the Kinkaid Act of 1904.

hot, dry air from southwestern United States and northern Mexico; cool, moderately dry air from the north Pacific ocean; or cold, dry polar air from the vast Canadian interior (Blair, 1941).

Variability in the amount of precipitation received from year to year is one of the outstanding climatic distinctions of the Box Butte Tableland. Recurring periods of dry years have been of much importance in the area's history. Dry years bring suffering, and when they are too severe or continued too long, the people are brought face to face with disaster; the landscape becomes marked by weather-beaten abandoned homes (fig. 10), bleaching bones of livestock which have died of thirst and hunger, and uncultivated fields from which the winds whip clouds of dust. Although the area experiences drought, it is not an annual condition as there are humid intervals in short periods of years.

The thunderstorm is a common phenomenon and usually brings quick relief from the high temperatures of a summer day. Hail often accompanies the more violent storms and at times does much damage to livestock and crops. Blizzards are of common occurrence, the large masses of polar air sweeping down over the High Plains with disconcerting unexpectedness. Temperatures may drop 40–50° F.

in the space of a few hours, with resulting losses to livestock wintering on the more exposed portions of the ranges. Such storms generally occur during the late winter or early spring months but may be expected at any time from late October to the middle of May. Modern means of weather forecasting, based on air-mass analyses and the uses of rapid means of communication, especially the radio, have done much to reduce livestock losses by giving ample warning of approaching cold waves or snowstorms. However, if winter storms are of great intensity and long duration, such as experienced during 1948–1949, heavy losses in livestock as well as in human lives may be expected.

Inasmuch as the extent of the area studied is quite large, especially in an east-west direction, and since there is a pronounced slope from west to east, variations in climatic conditions are present. Table 1 gives a climatic summary for the stations located within the boundaries of the study area; the climatic summary for Lusk, Wyoming, based on a 40-year record, is also included because of its close proximity to the northwestern corner of the area which is without weather observation facilities.

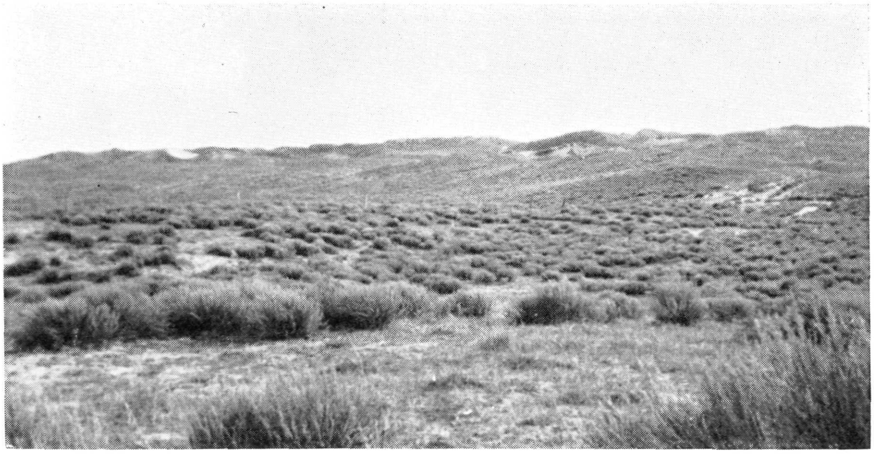

FIGURE 11. Sagebrush tract bordering sand dunes in southern Box Butte County. The soil is exceptionally deficient in moisture as well as in plant nutrients. A "blow-out" appears at the top of the ridge to the left.

### *Precipitation*

Agriculture on the Box Butte Tableland is dependent largely upon the yearly amount and distribution of precipitation; thus rainfall may rightfully be considered the most significant climatic factor in both crop and livestock production. The major difference between the Box Butte Tableland and the moister areas to the east and the drier areas to the west, lies in the fact that the rainfall of this upland tends to vary around a critical point for farming and ranching activities. Therefore even a slight reduction in precipitation seriously affects crop yields and stability of the livestock industry. Droughts west of the 100th meridian are often so severe and extended that they seriously limit a satisfactory rural economy. Man needs to recognize that periods of low precipitation are part of a climatic trend which runs its course beyond the range of human control, but that their influence can be greatly mitigated through careful application of agricultural methods adapted to semiarid conditions.

The amount of precipitation received on the Box Butte Tableland is determined chiefly by the strength and frequency of cyclonic storms, for this area is in the

## TABLE 1

*Climatic Summary*

| Station | County | State | Temperature | | | | | Killing Frost Average Dates | | | | Average Precipitation | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Length of Record | January Average | July Average | Maximum | Minimum | Length of Record | Last in Spring | First in Fall | Growing Season | Length of Record | January | February | March | April | May | June | July | August | September | October | November | December | Annual |
| | | | Yrs. | °F. | °F. | °F. | °F. | Yrs. | | | Days | Yrs. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. | In. |
| Agate (Elev. 4,400′) | Sioux | Nebr. | | | | | | | | | | 8 | 0.34 | 0.78 | 0.71 | 1.79 | 2.46 | 3.11 | 2.22 | 1.40 | 1.43 | 0.71 | 0.21 | 0.48 | 15.59 |
| Alliance (Elev. 3,971′) | Box Butte | Nebr. | 47 | 23.4 | 73.1 | 106 | —40 | 32 | May 12 | Sept. 27 | 138 | 52 | 0.52 | 0.55 | 0.89 | 2.05 | 2.60 | 2.64 | 2.38 | 1.72 | 1.18 | 1.09 | 0.53 | 0.54 | 16.27 |
| Hemingford (Elev. 4,256′) | Box Butte | Nebr. | | | | | | | | | | 10 | 0.29 | 0.57 | 0.75 | 1.99 | 2.34 | 1.92 | 2.20 | 1.89 | 1.63 | 0.88 | 0.22 | 0.47 | 14.95 |
| Sheep Creek C. (Elev. 4,200′) | Sioux | Nebr. | | | | | | | | | | 24 | 0.32 | 0.39 | 0.65 | 1.94 | 2.29 | 2.32 | 1.49 | 1.26 | 1.54 | 1.07 | 0.43 | 0.47 | 14.02 |
| Lusk (Elev. 5,007′) | Niobrara | Wyo. | 40 | 22.7 | 68.3 | 105 | —35 | 40 | May 26 | Sept. 18 | 115 | 39 | 0.43 | 0.50 | 0.82 | 1.66 | 2.95 | 2.40 | 1.61 | 1.18 | 1.07 | 0.85 | 0.43 | 0.60 | 14.50 |

Adapted from Climate & Man, Yearbook of Agriculture, 1941.

*rain shadow* of the Rocky Mountains. Normally the annual rainfall is less than 17 inches, and while the area may benefit from a late spring and early summer maximum, it is subject to great variability from year to year. Enough moisture does fall to induce a short grass vegetation, but on the whole trees fail to grow because of insufficient rain. Since much of the summer precipitation occurs during thunderstorms, rainfall is usually highly localized, erratic, and unreliable. Destructive hailstorms are not uncommon during this period, with the greatest number taking place in June and July.

TABLE 2

*Normal, monthly, seasonal, and annual precipitation at Alliance, Box Butte County, Nebraska, 1890–1941. (Altitude—3,971 feet.)*

| MONTH | PRECIPITATION | | | |
|---|---|---|---|---|
| | Mean | Total amount for the driest year: 1934 | Total amount for the wettest year: 1915 | Snowfall average depth |
| | Inches | Inches | Inches | Inches |
| December | 0.54 | 0.16 | 0.50 | 3.9 |
| January | 0.52 | 0.30 | 1.30 | 5.7 |
| February | 0.55 | 0.96 | 1.20 | 4.7 |
| Winter Season | 1.61 | 1.42 | 3.00 | 14.3 |
| March | 0.89 | 0.39 | 2.00 | 6.3 |
| April | 2.05 | 0.53 | 3.40 | 6.6 |
| May | 2.60 | 1.26 | 3.10 | 0.8 |
| Spring Season | 5.54 | 2.18 | 8.50 | 13.7 |
| June | 2.64 | 2.13 | 5.00 | 0 |
| July | 2.38 | 0.56 | 7.28 | 0 |
| August | 1.72 | 1.53 | 1.40 | 0 |
| Summer Season | 6.74 | 4.22 | 13.68 | 0 |
| September | 1.18 | 0.68 | 3.90 | 0.4 |
| October | 1.09 | 0.38 | 2.20 | 3.2 |
| November | 0.53 | 0.13 | 0.45 | 2.8 |
| Autumn Season | 2.80 | 1.09 | 6.55 | 6.4 |
| Year | 16.27 | 9.01 | 31.73 | 34.4 |

Tables 2–5 inclusive, prepared from data gathered by the United States Weather Bureau, present statistically some of the facts concerning the amount and distribution of rainfall at various points from east to west on the Box Butte Tableland and at Lusk, Wyoming, located in the western part of the Niobrara Valley and adjacent to the area. These stations vary considerably in altitude, Alliance having the lowest while Lusk has the highest.

The mean annual precipitation as recorded at Alliance, is 16.27 inches. This approximates 1⅓ acre feet of water per year, an amount hardly sufficient for satisfactory crop yields unless properly distributed throughout the growing season. The greatest annual precipitation ever recorded was 31.73 inches in 1915; there have been two other years with high precipitation records, 1892 with 24.75 inches and 1930 with 23.52 inches, but these fall far below the all-time 1915 record. The lowest precipitation recorded was 9.01 in 1934, a year of extreme drought throughout most of the Great Plains Region. The nearest approach to this record occurred in 1940 when 9.39 inches of rainfall were received. The annual amount

TABLE 3

*Normal, monthly, seasonal, and annual precipitation at Hemingford, Box Butte County, Nebraska, 1909–1919. (Altitude—4,256 feet.)*

| MONTH | PRECIPITATION | | |
|---|---|---|---|
| | Mean | Total amount for the driest year: 1910 | Total amount for the wettest year: 1915 |
| | Inches | Inches | Inches |
| December | 0.47 | 0.32 | 0.40 |
| January | 0.29 | 0.37 | 0.51 |
| February | 0.57 | 0.19 | 1.95 |
| Winter Season | 1.33 | 0.88 | 2.86 |
| March | 0.75 | 0.40 | 1.64 |
| April | 1.99 | 0.63 | 3.70 |
| May | 2.34 | 2.04 | 3.25 |
| Spring Season | 5.08 | 3.07 | 8.59 |
| June | 1.92 | 2.28 | 3.51 |
| July | 2.20 | 1.73 | 4.06 |
| August | 1.89 | 0.62 | 4.29 |
| Summer Season | 6.01 | 4.63 | 11.92 |
| September | 1.63 | 0.97 | 3.53 |
| October | 0.88 | 0.41 | 1.09 |
| November | 0.22 | 0.18 | 0.04 |
| Autumn Season | 2.73 | 1.56 | 4.66 |
| Year | 14.95 | 10.14 | 28.03 |

TABLE 4

*Normal, monthly, seasonal, and annual precipitation at Sheep Creek Camp No. 5, Sioux County, Nebraska, 1918–1941. (Altitude—4,200 feet.)*

| MONTH | PRECIPITATION | | | |
|---|---|---|---|---|
| | Mean | Total amount for the driest year: 1939 | Total amount for the wettest year: 1930 | Snowfall average depth |
| | Inches | Inches | Inches | Inches |
| December | 0.47 | 0.35 | 0.11 | 4.9 |
| January | 0.32 | 0.65 | 0.54 | 3.3 |
| February | 0.39 | 1.08 | 0.50 | 3.6 |
| Winter Season | 1.18 | 2.08 | 1.15 | 11.8 |
| March | 0.65 | 0.50 | 0.18 | 4.8 |
| April | 1.94 | 0.48 | 3.51 | 5.1 |
| May | 2.29 | 0.43 | 4.65 | 0.4 |
| Spring Season | 4.88 | 1.41 | 8.35 | 10.3 |
| June | 2.32 | 1.71 | 0.37 | 0 |
| July | 1.49 | 1.00 | 0.56 | 0 |
| August | 1.26 | 0.76 | 4.00 | 0 |
| Summer Season | 5.07 | 3.47 | 4.93 | 0 |
| September | 1.54 | 0.80 | 2.83 | 0.2 |
| October | 1.07 | 0.32 | 3.92 | 1.8 |
| November | 0.43 | 0.00 | 0.15 | 4.5 |
| Autumn Season | 3.04 | 1.12 | 6.90 | 6.5 |
| Year | 14.02 | 8.08 | 21.32 | 28.6 |

of snowfall varies from a trace to several feet, the mean annual being about 34.4 inches. The mean annual precipitation recorded at Lusk is 14.98 inches.

The light precipitation is reflected strongly in the vegetation, such as the short grasses, the failure of native trees to occupy the land except in scattered clumps along the more important drainage ways, and the presence of sagebrush in small tracts of Box Butte and Sioux counties, Nebraska, with larger areas in Goshen and Niobrara counties, Wyoming (fig. 11). The fact that climate favors the growth of grass rather than trees, has helped to make this tableland an important grazing section of the West.

TABLE 5

*Normal, monthly, seasonal, and annual precipitation at Lusk, Niobrara County, Wyoming, 1889–1941. (Altitude—5,007 feet.)*

| MONTH | PRECIPITATION | | | |
|---|---|---|---|---|
| | Mean | Total amount for the driest year: 1914 | Total amount for the wettest year: 1942 | Snowfall average depth |
| | Inches | Inches | Inches | Inches |
| December | 0.56 | 0.18 | 0.27 | 6.4 |
| January | 0.47 | 0.12 | 0.28 | 4.9 |
| February | 0.53 | 0.02 | 0.48 | 5.6 |
| Winter Season | 1.56 | 0.32 | 1.03 | 16.9 |
| March | 0.89 | 0.06 | 0.82 | 6.4 |
| April | 1.88 | 4.39 | 5.00 | 9.2 |
| May | 2.79 | 2.33 | 4.59 | 2.2 |
| Spring Season | 5.56 | 6.78 | 10.41 | 17.8 |
| June | 2.37 | 0.85 | 3.13 | 0 |
| July | 1.66 | 0.14 | 3.29 | 0 |
| August | 1.15 | 0.30 | 1.02 | 0 |
| Summer Season | 5.18 | 1.29 | 7.44 | 0 |
| September | 1.15 | 0.00 | 2.06 | 0.5 |
| October | 0.93 | 0.45 | 1.83 | 2.2 |
| November | 0.60 | 0.00 | 1.10 | 2.9 |
| Autumn Season | 2.68 | 0.45 | 4.99 | 5.6 |
| Year | 14.98 | 8.84 | 23.87 | 40.3 |

Variations in rainfall from year to year, and from a period of wet years to one of dry years, are well depicted by the productivity of the area as well as by the activities of the people. Rainfall is usually inadequate for the raising of crops common to the humid areas to the east unless irrigation or dry-land farming methods are employed. In some years to be sure, there is enough moisture to make dry farming and irrigation unnecessary, but in other years crops would certainly fail without them. Of the annual amount received, 77 percent falls from April to October inclusive, and more than 58 percent during the critical crop months, May to October, at which time the optimum conditions for evaporation prevail and transpiration reaches its maximum. In June, 16 percent of the total annual precipitation occurs, and in January, 3 percent.

The Alliance records show that the spring months, March to May inclusive, receive an average precipitation of about 5.54 inches or 34 percent of the mean annual. March receives a monthly average precipitation of 0.89 inches; April, 2.05 inches; and May, 2.60 inches. It is readily seen from these figures that there is a marked increase in the amount of precipitation received from the beginning to the end of the spring season, during which period the precipitation occurs in the form of rain or snow, or both. Occasionally there are prolonged periods of raw, drizzly weather and at such times practically no runoff takes place due to the gently falling of the rain, the porous nature of the soil, and the grass sod covering the greater portion of the tableland. Such rains are deemed especially favorable agriculturally because spring moisture is essential for small grains as well as for legumes and pasture lands; they also aid materially in the preparation of the seed bed for corn and grain sorghums.

The summer season, June to August inclusive, receives the greatest seasonal rainfall which totals 6.74 inches or about 40.8 percent of the mean annual. June, the wettest month of the entire year, has an average rainfall of 2.64 inches. Average precipitation for July is 2.38 inches, and for August 1.72 inches. During these months the rains are apt to be brief and pounding, temperatures high, humidity low, long periods of sunshine uninterrupted except for quick violent storms, and wind persistent and strong—all of these weather conditions tend toward greatly increasing evaporation, thereby considerably reducing rainfall effectiveness. Any variation from the normal annual or seasonal precipitation received interferes seriously with production of tillable crops, even though in some cases such variations may be above normal. The spring rains in 1942, for example, were unusually late and persisted so long that it was practically impossible to plant crops in sufficient time to assure their maturity before the first killing frost.

The fall or autumn season, September to November inclusive, has an average precipitation of about 2.80 inches, approximately 17 percent of the annual amount. Precipitation occurs mainly in the form of rain, most of which falls during occasional and irregular periods of cold, drizzly weather. The autumn moisture is essential to plantings of winter wheat and fall rye, both usually sown the latter part of September. Fall rains are favorable to the growth of lowland pastures upon which many ranchers depend in part for the feeding of livestock during the winter months.

The winter season, December to February inclusive, is a relatively dry season and has an average precipitation of only 1.61 inches, which is but 9.7 percent of the annual amount. January is the driest month, receiving only 0.52 of an inch of precipitation, as well as the coldest month of the entire year with an average temperature of 23.4° F. Precipitation during the winter season occurs mainly in the form of light snow which has its origin in cyclonic storms. These storms generally move with great rapidity, giving to the winter season highly changeable weather. When the snow forms a blanket over fall grains, it not only protects these crops from low temperatures and strong winds, but also contributes to the supply of soil moisture, thereby often improving the agricultural outlook for the coming year.

### *Temperature*

Cyclonic and anticyclonic storms, resultant of air mass movements from the colder northern regions and from the warmer southern ones, create frequent changes of temperature as well as of wind direction and velocity. Temperatures of the semiarid continental climate, such as experienced on the Box Butte Tableland, resemble those of the humid continental type, except that the extremes are greater. Table 6 presents statistically some of the data concerning the temperatures recorded at Alliance between 1895–1941.

The average annual temperature for Alliance, based upon a 46-year record, is 47.9° F., and the annual range in monthly means varies from 23.4° F. in January to 73.1° F. in July. Temperatures often reach 100° F., or more during July and August. The highest ever recorded was 108° F. on July 20, 1939, while the lowest was −40° F. on February 11, 1899; these two extremes give an absolute range of

148° F. The average annual temperature recorded at Lusk over a period of 50 years, is 44.2° F. which is 3.7° lower than that given for Alliance.

The spring months are generally cool and delightful with the number of crisp, sunshiny days far exceeding the cloudy ones. March is a month of great extremes, a period of transition from winter to spring with an average monthly temperature, as recorded at Alliance, of 34.5° F. in contrast to 45.3° F. for April and 55.9° F. for May. A comparison of average monthly temperatures for the spring months shows that there is a general increase of nearly 0.25° F. per day as the summer season approaches with an accompanying weakening of cyclonic and anticyclonic storms.

TABLE 6

*Normal monthly, seasonal, and annual temperature at Alliance, Nebraska.*
*(Altitude—3,971 feet.)*

| Month | Temperature | | |
|---|---|---|---|
| | Mean | Absolute Maximum | Absolute Minimum |
| | ° F. | ° F. | ° F. |
| December | 26.0 | 34.4 | 16.0 |
| January | 23.4 | 32.3 | 8.6 |
| February | 25.7 | 35.4 | 8.5 |
| Winter Season | 25.0 | | |
| March | 34.5 | 43.2 | 21.5 |
| April | 45.3 | 51.9 | 37.4 |
| May | 55.9 | 66.4 | 48.2 |
| Spring Season | 45.2 | | |
| June | 66.0 | 74.0 | 57.4 |
| July | 73.1 | 80.6 | 68.2 |
| August | 70.9 | 76.4 | 63.4 |
| Summer Season | 70.0 | | |
| September | 60.6 | 67.4 | 51.2 |
| October | 47.4 | 54.8 | 32.0 |
| November | 33.9 | 43.3 | 22.9 |
| Autumn Season | 47.3 | | |
| Year | 47.9 | | |

Summer days are usually quite warm and since the atmosphere is dry and clouds and fog rare, much sunshine prevails. Nights may be cool, the result of moderate altitude and rapid radiation, the latter being consequent upon dry air and clear skies. The summer months have an average temperature of 70.0° F.; June averages 66.0° F.; July, the hottest month of the year, 73.1° F.; and August, 70.9° F. Periods of hot days may be expected during the summer season, especially in July and August, and when they occur over a long period of time with little precipitation, damaging droughts are likely to ensue, especially when accompanied by desiccating southerly winds.

With the passing of summer into the autumn season, temperatures show a steady decrease, dropping from a monthly average of 60.6° F. for September to 47.4° F. for October, and 33.9° F. for November. The change from autumn to winter is more gradual than from winter to spring; clear, mild, frosty days and nights may prevail without notable change until December. The moderate temperatures of early autumn are often broken by short periods of chilly, stormy weather.

The winter season brings considerable temperature variability. Cold waves, during which the thermometer may drop 20° F. or more in a period of 24 hours, can be expected. The average for December is 26.0° F.; January and February are not only the coldest months of the year but hold the record for minimum temperatures. According to the Alliance records, February has had a low of −40° F. The monthly average for January is 23.4° F., and for February 25.7° F., with the temperatures rising rapidly after the latter month. Northerly and northwesterly winds are common during the winter season.

The growing or frost-free season decreases from about 138 days at Alliance, to approximately 115 days in the northwestern part. Latitude and altitude determine largely the differences in the length of the growing season from southeast to northwest. The average spring date for the last killing frost at Alliance is May 12 and at Lusk, May 26; the average autumn date for the first killing frost for the same stations is September 27 and September 18.

### *Sunshine and Cloudiness*

Winter months give rise to brief periods of cloudy weather. The somewhat cloudy spring season with its periods of drizzly weather is most suitable for small grains; the much needed sunshine for grain development and maturity comes during the summer months. Autumn days are generally sunny, an excellent condition for the proper drying of the corn crop as well as for preparing the ground for potato harvesting. Such days also favor the continuance of livestock grazing.

### *Winds*

Winds on the Box Butte Tableland are highly changeable throughout the year, due to the prevalence of cyclonic and anticyclonic storms moving eastward across the area. There is much wind, but no records of wind velocity have been kept at either the Alliance or Lusk weather stations. Records of prevailing wind direction have been kept at both places however and these show that during the period from about November to March inclusive, the prevailing wind direction is northerly and northwesterly. During the remainder of the year it is mainly from a southerly direction. The summer winds are warm and in late July and August have a pronounced drying effect. The high rate of air movement increases evaporation, intensifies droughts caused by rainfall deficiencies and high temperatures, and propagates heavy dust storms which are often referred to as *black blizzards*.

Winds although certainly variable, are quite dependable, a fact attested to by the popularity of the windmill for pumping water to meet livestock and domestic requirements; also wide-spread use of the *wind charger* for furnishing lights, and in some instances, power. While windstorms do occur and at times result in local damage, they are not especially destructive except when accompanied by hail.

There are those who believe the climate of the Box Butte Tableland is gradually changing but the same has been said regarding other areas as well. Such a conclusion is no doubt due to faulty reasoning, poor memory, and much wishful thinking. It is perhaps entirely true that the climate of this upland as well as that of any other area is subject to more or less prolonged fluctuations, but climatic records kept over a period of more than fifty years fail to show any definite evidence of material progressive changes.

## NATIVE VEGETATION

The tableland, lying in a zone of transition from humid to arid conditions, is characterized by a short, native grass cover (fig. 12). In many sections the area has the appearance of a vast meadow land, sometimes green, sometimes brown, depending upon the season and amount of rainfall received. Since the greater portion of the annual precipitation occurs during the spring and early summer months, the grasses achieve their greatest growth in this period. Many of the grasses cure upon the ground during the late summer and early fall, offering excellent grazing for livestock in the winter months if snowfall is light. Vigor of the grasses varies greatly with the rainfall from year to year and thus there is a close correlation between the grasses and the number and quality of livestock raised. Owing to the depth and compactness of the sod, and the general lack of trees, the pioneer made extensive use of the prairie sod in the construction of houses and barns.

The grasses, generally speaking, can be divided into two principal groups, namely, the short grasses, and the tall grasses (Greenslet, 1929). The short grasses are shallow-rooted and occupy areas in which the moisture penetration usually does not exceed two feet. The tall grasses on the other hand are, comparatively speaking, deep-rooted and grow where moisture penetration is greatest.

FIGURE 12. An excellent stand of grasses bordering a strip of sand hills. Such ranges are a valuable adjunct to every cattle ranch. Part of the grasses will be cut, stacked, and held in reserve for winter feeding.

These latter grasses, although generally limited to valley areas, do occur in upland swales where runoff from adjacent lands causes favorable moisture conditions in the low-lying basins. The valley and basin tracts usually produce a good growth of grasses and therefore are important for native hay production.

Sages, as previously indicated, are found in southwestern Box Butte, southern Sioux, on large tracts in Goshen, and to a limited extent in Niobrara County southeast of Van Tassel, Wyoming. Some of the plants grow to heights of four feet or more; a few are suitable for browsing by cattle and sheep although the nutritious value of the sage is considered low at best.

The abundance of wild flowers in late spring or early summer is noteworthy. The water lily is found in the marshlands; the dandelion, in the low-lying meadows; and the wild rose, prairie daisy, and sun flower, on the uplands. The dandelion maintains itself rather precariously in competition with the more hardy of the native grasses.

Prior to the advent of cattle barons, sheep herders and settlers, there existed a more or less continuous sod where an equilibrium had been established between the various forms of plant life living together in the same region. The native grasses such as western wheat grass, buffalo grass, needle grass, the bluestems and the gramas had developed resistance to the climatic hazards encountered. The same was also true of the wild animal life. This so-called *balance of nature* was upset by the incoming of stockmen and farmers so that today many of the less desirable grasses have increased at the expense of the better ones, a condition due largely to over-grazing. Introduction, through farming, of many undesirable foreign species has also helped to bring about this change. Prickly pear, a type of flat-jointed cactus, has moved into areas where the original grasses have been injured or destroyed; the spread of this plant is exceedingly rapid during periods of drought, especially on lighter soils.

Although the tableland is nearly treeless, it is not so devoid of tree life as commonly believed by people not familiar with the area. Clumps of cottonwood, willow, and elm are encountered along portions of the major streams; western yellow pine and red cedar, and quaking aspen occur on the Rawhide Buttes, along the upper slopes of Pine Ridge (Goshen County, Wyoming), and in some canyon tracts of the Hartville Uplift. Trees along the crest of Pine Ridge, while rarely attaining a diameter of more than two feet and a height of over sixty feet, are a prominent feature of the landscape in that part of the tableland.

## SOILS

There is perhaps no environmental element of more significance in determining the industry of a rural population or its success than is soil. The true character of agricultural possibilities is revealed by the soil and he is indeed a wise man who selects that soil best suited for his specific needs. The geographic importance of soil is not so easily perceived or recognized as are the characteristics of climate and differences in relief, but it is nevertheless equally significant. Soils of the Box Butte Tableland represent both residual and transported types, the latter soils displaying eolian as well as alluvial characteristics. Derived largely from disintegration of the underlying Arikaree formation, the soils are chiefly a mingling of silt and fine sand, generally quite rich in lime.

From east to west across the tableland there is a definite change in soil coloration, ranging from a dark to a light brown. This is due chiefly to a decrease in humus content, indirectly occasioned by a lessening of precipitation. The semiarid conditions necessitate careful handling in order to prevent collapse of the soil structure, a situation easily brought about because of low rainfall, insufficiency of humic materials, and rapid destruction by wind and water when not protected by a vegetative covering (fig. 13). Improper handling of the soil generally causes severe slumping and the resulting powdery mass is easily and quickly removed by the wind; the soil then piles up along fence rows, in road ditches, and around buildings, or is carried to distant areas.

The soils are largely pedocalic. In a few instances they are alkaline and give rise to alkali-incrusted flats which are of practically no value for either tillage or grazing. Box Butte Tableland soils are generally of higher fertility than those of humid regions because the soluble constituents necessary to the growth of plants are less leached. The common soil deficiency is not in plant food but in moisture, a condition susceptible of some solution through the adoption of dry farming practices and limited irrigation. Some of the soils are very sandy and used chiefly for grazing purposes.

In view of the fact that soil is the greatest single natural resource of the Box Butte Tableland, the future of the area will continue, as it has in the past, to be closely bound to the land and the use which man makes of it. Misuse of the soil quickly invites disaster and this area, like other parts of the High Plains Region, has had its share of misfortune because of improper land use.

## NATIVE WILD LIFE

The Box Butte Tableland supports a fairly abundant wild life. Here are found antelope, deer, coyote, fox, wolf, bobcat, and badger. Some of the smaller denizens are the skunk, jack rabbit, prairie dog, beaver, muskrat, and mink. None of the animals or rodents mentioned, excepting the jack rabbit and prairie dog, appear in any large number although during Indian occupation they were numerous as was also true of the American bison and elk. Several of the animals such as deer, antelope, and beaver, are now protected by state and federal laws. The coyote and wolf prey upon both wild game and livestock; at times these animals cause serious losses to farmers and ranchers.

A few varieties of snakes occur and of these the rattlesnake is the most venomous. During the summer and early autumn months a rattler may be expected almost anywhere. In late fall the snakes seek their dens, usually to be found in outcrops of the underlying bedrock formations. On warm fall days it is not an uncommon sight to observe numerous rattlesnakes lying among the rocks and basking in the sunshine. With the advent of cold weather the snakes crawl into the dens and do not appear again until late spring.

FIGURE 13. Approximately six inches of the top soil, loosened by plowing and unprotected by a vegetative cover, has been swept away by high winds. The land, now abandoned, offers no encouragement to others.

Bird life is plentiful. The most common are the gull, eagle, hawk, owl, curlew, meadow lark, mocking bird, flicker, bob white, robin, magpie, and grouse. The prairie chicken has largely disappeared, but in its place has been introduced the pheasant. Ducks and geese, like the pheasant, are common game birds and much sought after by hunters. The bird life not only adds beauty and interest to the area but does much good in destroying insect life harmful to both the native vegetation and cultivated crops. Among the harmful insects the grasshopper and blister beetle are perhaps the best known and usually do the greatest amount of damage.

## WATER RESOURCES

The water supply of any area is of great importance but it takes on a special significance in such semiarid regions as the Box Butte Tableland. The quality as well as the quantity of available water is of great concern to the inhabitants. Water supplies are derived from two main sources, namely, surface water and ground water, with the latter secured from the fluviatile mantle of the uplands and from the alluvial deposits in the valleys.

Surface water is exceedingly limited, with Box Butte, Snake, and Rawhide creeks supplying the bulk. Following heavy rains a number of ponds appear on the flat phase of the tableland, but these generally last only a few days at best and are therefore of little value as watering places. Some artificial stock ponds have been constructed and while not extensive, they have proved their worth as reservoirs of runoff waters. Kilpatrick Lake, man-made, is the only sizable body of water on the entire tableland; this lake, with a surface area of about forty acres, and located on Snake Creek in western Box Butte County, is supplied by both surface runoff and springs. A few small lakes are usually found in the eastern part of the same county, especially along the fringes of the sandhills.

Scarcity of surface water has caused the tapping of ground water sources, and fortunately the supply seems to be abundant. Apparently it is rapidly replenished by subterranean flow from the west and northwest as well as through local precipitation. The absorption of rainfall is especially high in the sections where the underlying bedrock is near or at the surface. A dense clay formation forms an impervious seal and the ground water occurs within the overlying Tertiary materials. The ground water has a particular advantage in the fact that it is relatively cold, the temperature varying from 50° to 54° F.

On the tabular sections of the upland the ground water table lies at depths varying from 150 to 300 feet as indicated by differences in the depths of wells throughout the area. Usually the wells are located in low-lying places so as to more readily tap the underground supplies. There are some instances where wells have been drilled directly on the crest of a ridge or hill in order to obtain greater windmill efficiency. In a few cases two or more windmills have been placed side by side on some prominent point because the location proved exceptionally good for watering range stock.

Although the quality of the water is excellent, the chief drawback to underground supplies is the depth at which they often lie. Well drilling is expensive and the costs have greatly retarded the development of pump irrigation on upland areas. According to the Conservation and Survey Division of the University of Nebraska, there are approximately forty irrigation wells in the Nebraska portion of the Box Butte Tableland, varying in depth from 93–458 feet and irrigating about 5,242 acres. In the larger basin areas and drainage ways, satisfactory water supplies for livestock and domestic purposes are within twelve, eighteen, and thirty feet of the surface. Introduction of the windmill was a boon to the area and today it is certainly *land of the windmill.* This is due to favorable wind conditions, a pressing need of water for farm and ranch use, and the general lack of permanent streams.

Ground water resources are of immeasurable value to the tableland. Droughty conditions cause the loss of most surface water, leaving the underground supplies in many instances the only source. With a better stabilization of agriculture in this part of the High Plains Region it is to be expected that more and better wells will be put down; farmers and ranchers will continue to develop limited pump irrigation in order to assure themselves of adequate water supplies for crops and livestock. At the present time one can hardly predict what influence these increased demands will have upon the present level of the water table; such demands may cause a lowering of the water table, resulting in the loss of many wells now considered satisfactory.

## TRANSPORTATION

The people living on the Box Butte Tableland, like those in most sections of the semiarid and arid West, have always been confronted with the problem of adequate transportation facilities, due largely to the sparseness of population as well as to the general low productivity of the land. During the early period of settlement the only means of transportation other than by stagecoach and freighter, was that offered by the railroads; in more recent years highways have played an ever increasing role in breaking down the isolation of farm and ranch, village and town.

Main line of the Burlington Railroad from Kansas City, Missouri, and Lincoln, Nebraska, to Billings, Montana, passes through Alliance, Hemingford, and Crawford, Nebraska. Alliance is a division point of the Burlington as well as a junction for the Burlington's line to Denver, Colorado. The central and western sections of the tableland are without railroad facilities and therefore must depend chiefly upon the Chicago and Northwestern Railroad's line extending from Omaha, Nebraska, and Sioux City, Iowa, to Lander, Wyoming, and upon the North Platte Valley lines of the Burlington and Union Pacific. The Chicago and Northwestern more or less follows the Niobrara from Glen, Nebraska, to Lusk, while the Union Pacific traverses the valley of the North Platte into Wyoming.

FIGURE 14. A poorly graded road makes travel difficult. This "country road" is the only route of travel available to several widely separated ranchsteads. Heavy rains and snows may close such roads for weeks at a time, thus adding to the ever present problem of isolation.

The area is better served by highways than by railroads, but still there are large sections remote from highway facilities. Two federal routes tend to parallel the tableland. Federal Highway No. 26 follows the North Platte Valley from Lewellen, Nebraska, to Guernsey, Wyoming, passing en route through the valley towns of Oshkosh, Lisco, Broadwater, Northport, Minatare, Scottsbluff, Mitchell, Morrill, and Henry, Nebraska, and Torrington, Lingle, and Fort Laramie, Wyoming. To the north of the upland is Federal Highway No. 20. This route passes through the White River Basin of northwestern Nebraska, across the Dawes Tableland to the vicinity of Van Tassell, Wyoming, and then follows along the valley of the Niobrara River to Lusk and beyond. The only federal highway crossing the area is Highway No. 85, and it traverses the western section, connecting Lusk and Lingle.

Four state highways serve portions of the Nebraska section of the Box Butte Tableland and connect with federal highways. State Highway No. 2 enters Alliance from the east, turns northwestward and passes through Hemingford, Marsland, and Crawford. This road offers a direct route from Alliance to the Black Hills area of South Dakota. State Highway No. 19, a part of the Denver-Black Hills Highway, extends from Alliance southward to the North Platte Valley and northward to Chadron. State Highway No. 87 enters Hemingford from the east and follows a westerly and southwesterly route to Scottsbluff. State Highway No. 29, a secondary graveled road, connects Mitchell and Harrison. Bus service is to be had only on state highways No. 2 and 19, or on federal highways No. 20 and 26. Western Air Lines normally operates two flights daily between Denver and Minneapolis, with stops at Alliance.

In considering the low population density, approximately five persons per square mile, it might be said that transportation facilities on the Box Butte Tableland are adequate. However, it should be recognized that from the viewpoint of the general welfare of a people this area is inadequately served by both railroads and highways, facilities which do much toward making possible the normal social development of a people. Still, it is not to be expected that any additional major routes of transportation will be developed in the near future because the general sparseness of the population and low productivity of the land do not warrant sizable expenditures. Much of the area will remain in dependence upon unimproved roads (fig. 14) and primitive trails for connections with the existing highways, and distance will continue to hinder social contacts and retard the movement of commodities between farm and ranch to the ultimate consumer as well as between factory and the rural buyer.

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